

Evaluation of Mathematical Algorithms and Education Technology Used to Improve the Operative Yield in an Electronic Industry in Tijuana, Baja California, Mexico

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ABSTRACT

The use of mathematical algorithms in industrial operations is very relevant because can determine the principal steps of the flow production and to detect very fast and easy, some possible errors of workers of the manufacturing areas and of industrial equipment, machinery of systems utilized in the industrial process used to the manufactured products process. This investigation was made in an electronic industry installed in the Tijuana city, which is considered an industrial city and located in the northwest of the Mexican Republic. This scientific study was very important because with the mathematical algorithms, was supporting to increase the productivity and quality yielding of the electronics industry where was made this investigation. The scientific study was made in 2022, where was utilized some statistical methods using the Cronbach coefficient and making an interview to the managers of this electronic industry evaluated. The education technology method used in this investigation was very relevant to improve the productivity and quality indices, because students of a university that participated were important homework's in the industry evaluated.

Keywords: Mathematical algorithms; Electronics industry; Productivity and quality indices; Educational technology; Cronbach coefficient.

Introduction

Exists a lot methods to evaluate and improve the industrial process in industrial companies, especially in the electronics industry where was made this investigation, being to reach the productivity and quality levels and to increase these relevant parameters that supports to maintains and receive economic gains, which are very followed by directive and managers of the industrial companies in any place of the world (Akpınar et al, 2014).

The use of mathematical algorithms in a lot activities, supports to determine the impact or grade of all functions, classifying for example in principle, secondary or tertiary functions, being in more functions in sometimes, and depending of the type of industrial processes required to the fabrication of products in the manufacturing areas of industrial companies (Olivera et al, 2016).

These mathematical algorithms are used to detect very easy and quickly some possible errors of mal function of industrial equipment, machinery and systems, utilized in the industrial operations; and can cause defective products manufactured (Swat et al, 2014).

Electronics industry

Is an important industry in the worldwide, because manufacture a lot products used daily for a lot persons in any place of the world (Bag et al, 2016). Have a diverse type of industrial process, with different flow process, and being the most used the linear flow process, U flow process and manufacturing cells to some and different type of industrial operations (Branger et al, 2015). The principal electronic products fabricated by this type of industry, were the computers, cell phones, tablets, electronic sensors to other type of industries as optical sensors to security applications in car vehicles, aircrafts, space vehicles, to avoid the stolen actions and other important daily activities (Yan et al, 2015; Wang, 2016).

Mathematical algorithms

Are very relevant in any type of the daily activities, where was used to have the optimal flow process in each industrial operation of the manufacturing process of any type of industrial companies in any place of the world (Chen et al, 2018). This type of action represents a series of steps as operations or functions, being important to evaluate a diverse of actions of workers of manufacturing areas or industrial equipments, machinery and systems, to generate efficient operative yielding and the adequate activities to make the optimal industrial operations and obtain the productivity and quality required, and increasing these parameters constantly (Kellegöz et al, 2012). The mathematical algorithm is used in the productive chain of any type of industrial companies, and was used to predict the behavior of the productivity and quality indices in the manufacturing areas. The main purpose of evaluate the use of mathematical algorithms in this investigation, is to improve the efficiency of the industrial operations and increase the productivity and quality indices (Shaheen et al, 2015).

Educational technology

Was utilized an educational technology method to generate the teaching-learning process of expert professors of any university of this industrial city that works in the electronics industry where was the scientific study, and students were supported in the improvement continuous made in the industrial processes of the manufacturing areas (Lu, 2017). This is interesting because increased the educational quality indices of the university that participate in this investigation, reaching a good status between the educational institutions (Hayman et al, 2015). Also, was evaluate the use of computer systems with mathematical algorithms between the education sector and the industrial companies in this industrial city, where are around 350 industries, as aerospace, automotive, biomedical, electronic, metallic, plastics and textile; as the most type of industries installed in Tijuana city. The utilize of computer systems in industrial activities and in the teaching-learning process, is very relevant in the educational technology methods, to observe the increase of productivity and quality levels in the industrial companies and the increase of quality in the educational institutions (Da Silva, 2021).

Use of mathematical algorithm to relate the educational and industrial operations

In any place of the world, where is located any type of industry, ca uses mathematical algorithms to control the industrial operations, where is showing step by step each industrial activity, in according of the methods of fabrication and the flow processes (Fattahi et al, 2011). In this type of industrial the most flow process is the linear flow process and sometimes is in U flow process added in sometimes to manufacturing cells to make some complex industrial operations (Cheng, 2017). The mathematical algorithms can evaluate also, the functionality of industrial equipments, machinery and systems; and also, can analyze the operative yielding of each worker of the industrial process make in the manufacturing areas (Alexopoulos et al, 2016). Some complex industrial operations in the electronics industry, as manual activities, is the welding actions, where is necessary be patient and have experience to joint the electronic components in the electronic boards, using tin material and heat iron, to the welding process. Figure 1 illustrate an example of a mathematical algorithm, where is represented each step of one part of the industrial flow process (Kusiak, 2017). Figure 1 shows the welding process of a manufacturing cell located next to the linear flow production in the electronics industry evaluated, presented the actions with good or bad material as same with the electronic boards, where are bad are collocated in a plastic recycle recipient to be separated the better

of these electronic components to be used later. And also, illustrates the welding process and the checking the welding process (Hagel et al, 2015).

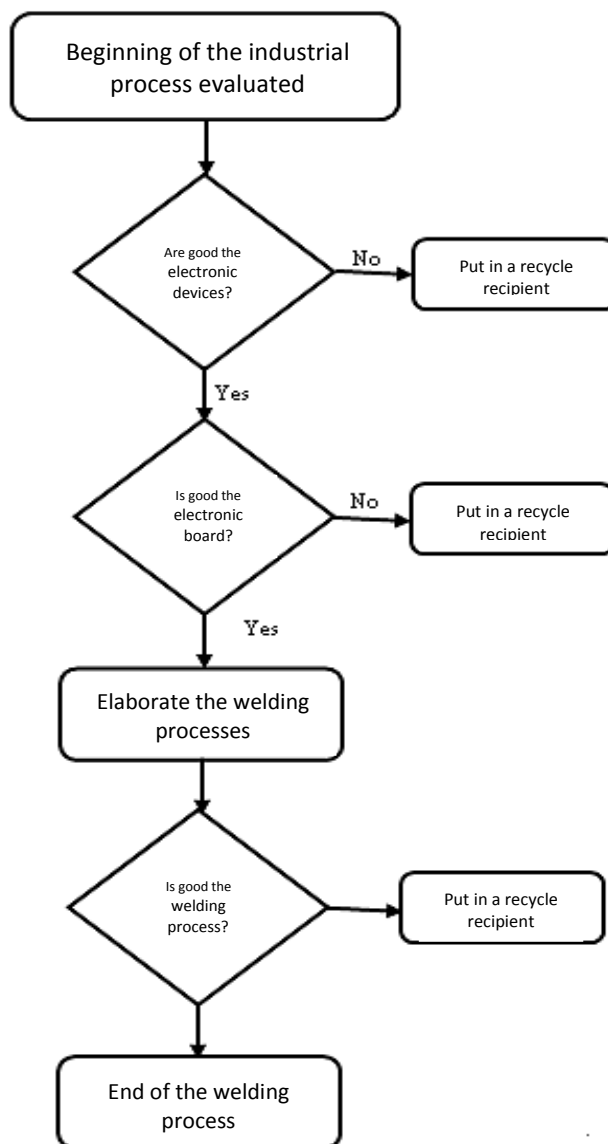


Figure 1. Mathematical algorithm on the flow process (manufacturing cell operation) in the electronics industry evaluated (2022) - SOURCE: Analysis of the investigation

Methodology

This investigation was made to determine the necessity of use mathematical algorithms in the industrial process related the educational technology and industrial knowledge of the teaching-learning processes, and having an increase in the education quality of the university that participated with the expert professors of this scientific study and the manufacturing process of the electronics industry where was made this investigation. This scientific study was made in two steps, as is showed now:

(a) Evaluation of the use of educational technology method, with the application of mathematical algorithms, where was related the teaching-learning process and the experience of professors that works in the industrial activity where was made this scientific study.

(b) Correlation analysis of the productivity and quality with the use of the mathematical algorithms and an analysis with the Cronbach coefficient.

Results

This was a relevant investigation, where was evaluate the use of the mathematical algorithms where was analyzed the educational technology as a new teaching-learning process and the experience of professors that works in the industry evaluated, involving the productivity and quality indices of the industrial activities and the education quality levels of the university that participate in this scientific study. The evaluations were made with the Excel program.

Evaluation of the use of educational technology

In this step was made the evaluation of the use of this relevant technological tool used in the educative activities to improve the quality of the teaching-learning process, with expert professors that works in the industry evaluated. In this investigation was observed in figure 2, the analysis in percentage of the use of the educational technology and its relation with the industrial activities, illustrating that in blue color (0%-20%) the major resistance of some students and some teachers to use technological tools in diverse type of schools in different levels, especially in the high school and universities schools, as is showed in figure 2. In the orange color (21%-40%) are less students and professors that resist the use of technology tools, followed by the gray color with 41% to 60%, where are less that the first color, and finally the yellow color with 61% to 80% and green-blue color with 81% to 100%, indicating that every tome are less students and professors with this resistant to use the technology in educational and industrial activities. The students and professors with major resistant in this scientific study were with age higher than 50 years.

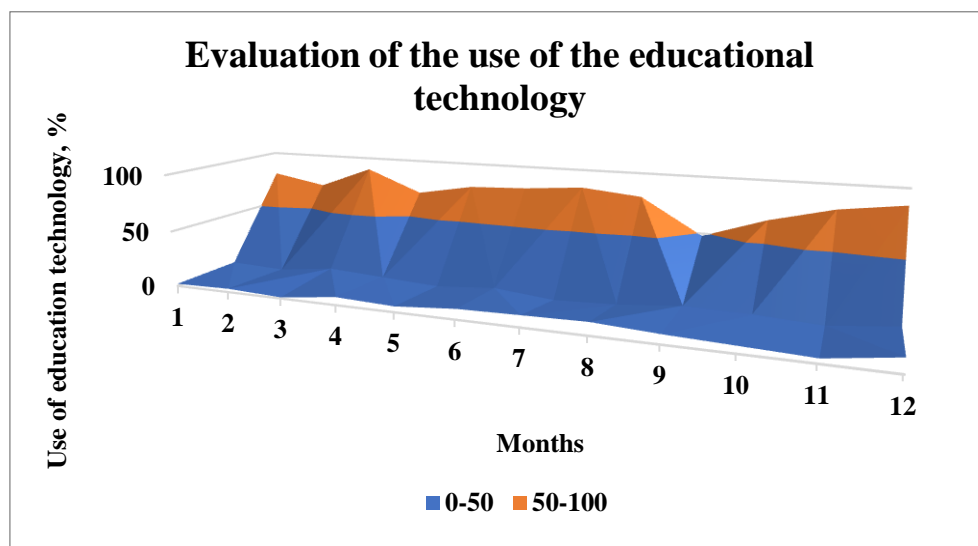


Figure 2. Evaluation of use of the education technology and the relation with the industrial activities (2022)

Correlation analysis of the productivity and quality indices

This part of the investigation was to analyze the correlation rate of the use of educational technology and the productivity and quality indices in an electronics industry of this industrial city and observed in figure 3.

Correlation analysis of the productivity and wuality indices and the use of educational technology

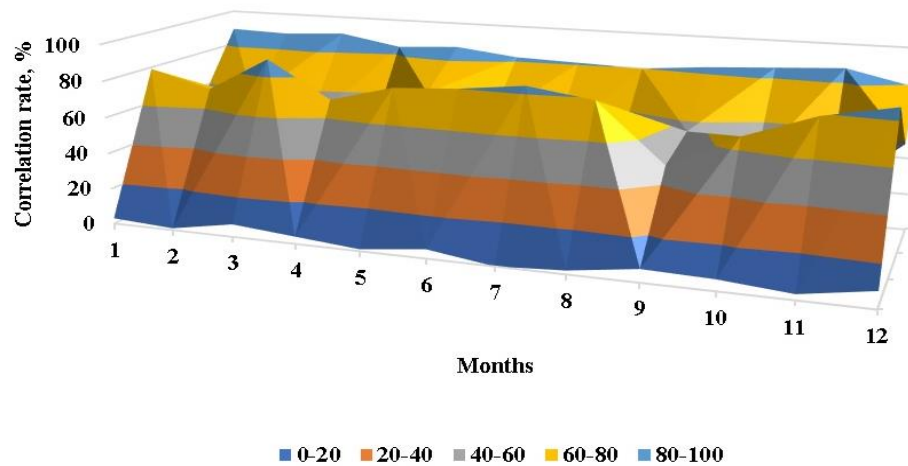


Figure 3. Correlation analysis of education technology and productivity and quality analysis (2022)

Figure 3 shows the dynamic analysis with the correlation rate by diverse colors as is represented in this figure, where was observed that in blue color (0%-20%) was the less level of the corrosion rate, followed by the orange color from 21% to 40%, indicating that was bit major of the last color and when was from 41% to 60% was bit better, and with this to gray color and green-blue color from 61% to 80% and 81% to 100% respectively better, indicating the necessity of use educational technology in educative institutions especially with mathematical algorithms, and related with the productivity and quality indices of the industrial company where was made this investigation.

Cronbach coefficient analysis

This relevant aspect was improved the validation of use the computer systems and educational technology with mathematical algorithms to determine the grade of positive impact in the industrial activities of the electronics industry evaluated with the questions described in table 1 and the analysis illustrated in table 2, and applied I March 2022, and validating each item as is showed in table 2. The same questionnaire was carried out again. Only this time, it was done to the eight managers of the evaluated industrial company, being accounting, engineering, human resources, maintenance, materials, production, quality and industrial safety; showing the result for the good and regular item, without the bad item (because no one answered about this item), in table 1, to made the Cronbach coefficient analysis.

Table 1. Analysis of an opinion of managers about the use of the computer systems with mathematical algorithms in manufacturing process of the electronics industry evaluated (2022)

Scale	Good	Regular	Bad
Questions			
1. How consider about workers of manufacturing aeras of this industry evaluated about the experience in the information technology thematic?			

2. What think about is necessary be constantly training in the information technology thematic?			
3. Do you consider if is necessary apply the information technology thematic in the manufacturing processes of this industry evaluated?			
4. What think about is necessary invest to the information technology systems and the industry tools as mathematical algorithms?			
5. Do your considerer that the use of the information technology systems and the industry tools as mathematical algorithms have high cost?			
6. Do you think it necessary to use computer systems with mathematical algorithms in manufacturing processes of this evaluated industry?			
7. Do you consider it is necessary to have expert personnel to apply computer systems with mathematical algorithms in manufacturing processes of this evaluated industry?			
8. Do you think it is difficult to understand the learning of computer systems with mathematical algorithms in manufacturing processes of this evaluated industry?			
9. Do you consider constantly developing training courses for your personnel in the manufacturing areas on the topics of the use of computer systems with mathematical algorithms in manufacturing processes of this evaluated industry?			
10. Do you think that with the computer systems with mathematical algorithms in the manufacturing processes of this evaluated industry, the productivity and quality indices will be constantly increasing?			

Table 2. Evaluation of opinion of eight managers after application about the use of the computer systems with mathematical algorithms in manufacturing process of the electronics industry evaluated (2022)

Items Questions	Good	Regular	Bad	AIT-IOT*	
				Good	Regular
1	2	1	2	7	1
2	1	3	1	7	1
3	3	1	1	8	0
4	2	2	1	6	2
5	4	0	1	8	0

6	1	2	2	8	0
7	1	3	1	7	1
8	3	1	1	6	2
9	2	3	0	8	0
10	3	1	1	8	0
Average (μ)	$22/10 = 2.2$	$17/10 = 1.70$	$11/10 = 1.10$	$73/10 = 7.3$	
Var (S^2)	0.96	1.01	0.29	6.1	
$\sum S_i^2 = 2.26$					

*AIT-IOT. Analysis of action after applied the Internet 4.0 Tool as Internet of Things

in the manufacturing process of the automotive industry evaluated.

K: El número de ítems = 3

S_i^2 : Sumatoria de Varianzas de los Ítems = 2.26

S_T^2 : Varianza de la suma de los Ítems = 6.1

α : Coeficiente de Alfa de Cronbach

$\alpha = [(K)/(K-1)] * [(1-(S_T^2 / S_i^2))] = [3/(3-1)] * [(1-(2.26/6.1)] = [3/2] * [1-0.37] = 1.5*0.63 = 0.94=94\%$.

As the Cronbach coefficient is 94%, this indicate that the eight managers were agree the use of the use of the industry 4.0 tool as internet of things, because they were observed an increase in the productivity and quality, and for this reason increase the economic gains of the automotive industry evaluated and the bonus of each year for the sales in the may month.

Conclusions

This scientific study was relevant in the determination of use the mathematical algorithms to relate the educational technology with the industrial activities, where was applied in the improvement continuous in the manufacturing areas of the electronics industry evacuated of this industrial city. The results illustrated interesting aspects as the necessity to use these mathematical methods, to control the industrial process and with this reach the goals of the production quantity and the productivity and quality indices, and search daily increase these important factors in the generation of the economic gains of each industrial plant in the worldwide, and avoid the concerns of the directive and managers of industries.

Declarations

Source of Funding

This research did not receive any specific grant from funding agencies in the public, or not-for-profit sectors.

Competing Interests

The authors declare no competing financial, professional and personal interests.

Consent for publication

We declare that we consented for the publication of this research work.

Availability of data and material

Authors are willing to share data and material according to the relevant needs.

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